these small antennas, and the Commission did not note any such complaints in its *Notice.* This is in stark contrast to the situation the Commission faced in 1986 when it amended its Ku-Band rules to deal with numerous complaints of interference.[37] Given the lack of any complaints, there is simply no basis to reduce the power radiated from antennas that fall within the 29-25 log theta envelope at 2° and beyond.[38]

b. The Proposed Standards Are More Stringent Than Those of Other Regulatory Regimes

The degree to which the proposed rules would unreasonably burden U.S. VSAT operators is apparent when they are compared to the analogous international rules and the operation of international satellite systems. The International Telecommunication Union ("ITU") allows a higher off-axis EIRP spectral density toward adjacent GSO satellites than the proposed rules would allow, and both Intelsat and Eutelsat successfully operate under those ITU standards.

The current FCC rules for routine applications limit the EIRP spectral density radiated toward adjacent satellites from a VSAT earth station transmitting digital services to 7.5 dBW/4kHz.[39] The proposed rule for small antennas would reduce this, even for antennas that fall within the 29-25 log theta envelope at 2° from the main beam axis, by

[37] *See* In the Matter of Amendment of Part 25 of the Commission's Rules and Regulations to Reduce Alien Carrier Interference Between Fixed-Satellites at Reduced Orbital Spacings and to Revise Application Processing Procedures for Satellite Communication Services, *Notice of Proposed Rulemaking*, 2 FCC Rcd. 762 (1987).

[38] Assuming that antennas that fall within the 29-25 log theta envelope at 2° and beyond are defined as compliant, Spacenet/StarBand agree with the framework of proposed Section 25.220 for applications proposing to use antennas that do not fall within the 29-25 log theta envelope within 2° from the main beam axis.

[39] The maximum antenna input power spectral density for VSAT remote stations transmitting digital services is -14 dBW/4kHz. *See* 47 CFR §§ 25.134 and 25.212 (2001). The maximum antenna gain 2° from the main beam axis is 29-25 log(2) dBi, or 21.5 dBi. *See* 47 CFR § 25.209 (2001). Combining these requirements gives 21.5-14 dBW/4kHz, or 7.5 dBW/4kHz.

as much as 6.3 dB.[40] In contrast, the ITU recommendation for maximum off-axis EIRP spectral density toward adjacent satellites is 17.1 dBW/4kHz, or 9.6 dB greater than the current FCC limit for routine approval.[41]

Intelsat, which has the widest distribution network of any satellite communications company, connecting customers in more than 210 countries and territories worldwide with a global fleet of 19 geostationary satellites, adopts the ITU recommendation and limits the power spectral density radiated toward adjacent satellites to 17.1 dBW/4kHz.[42] Similarly, Eutelsat, with 18 geostationary Ku-Band satellites providing coverage of Europe, Africa, large parts of Asia, and interconnectivity with the Americas, limits the power spectral density radiated toward adjacent satellites from earth

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[40] *See Notice* at Appendix B, proposed Section 25.220(c)(1). The actual reduction would depend on the particular antenna. For the 0.85 meter antenna discussed in Appendix A of the *Notice* it would be nearly 5 dB, the amount of gain above the 29-25 log theta envelope exhibited by that antenna 1.25° from the main beam axis. *See Notice* at Appendix A, Figure 12. A 0.78 meter circular antenna that is within the envelope beginning at 2° would require a reduction of approximately 6.3 dB. Smaller antennas would presumably be required to reduce the spectral density even more.

[41] *See* International Telecommunication Union Rec. ITU-R 524-5, § 3 (requiring off-axis emissions to fall within a 39-25 log theta dBW/40kHz envelope for theta from 2.5° to 7°; converting to dBW/4kHz and evaluating the logarithm of theta = 3 yields 17.1 dBW/4kHz toward the adjacent satellites in a 3° spacing environment.).

[42] *See* Intelsat Standard G, Performance Characteristics for Earth Stations Accessing the Intelsat Space Segment for International and Domestic Services not Covered by Other Earth Station Standards, IESS-601 (Rev. 10A) at § 3.3.1 (Nov. 20, 2000) (referencing Rec. ITU-R 524-5). Intelsat also requires the gain of small Ku-Band VSAT antennas to fall within 32-25 log theta dBi from 100 lambda/D degrees to 48°, where "lambda" signifies the wavelength of the emission and "D" is the diameter of the antenna. *See id.* at § 3.1.1(c). For the representative 0.85 meter antenna considered in the *Notice*, see Appendix A, Figure 12, Intelsat requires the gain to fall within the 32-25 log theta envelope from 2.52° to 48°, *see* IESS-601 at § 3.1.1(c). (These mandatory gain requirements apply to new antennas. Intelsat gives a non-mandatory "design objective" of containing 90% of sidelobe peaks within a 29-25 log theta dBi envelope. *See id.* at § 3.1.1(a).) For some small antennas, the pattern restrictions of § 3.1.1(c) together with the Intelsat main-axis EIRP limit may result in somewhat lower allowable radiation toward adjacent satellites than the off-axis restriction itself.

stations with symbol rates of 2.5 Msymbols or less to the same ITU standard, 17.1 dBW/4kHz.[43]

Satellites in these systems are routinely exposed to interference levels as much as 9.6 dB above the level allowed by the current FCC rules, and as much as 15.9 dB above the levels to which proposed Section 25.220 would restrict some smaller antennas authorized under the reduced-power option. Yet, the Intelsat and Eutelsat systems function properly without suffering from or causing harmful interference. Further, domestic satellites tolerate interference from analog earth stations, which are allowed to transmit with 6 dB more power density than digital stations.[44] This real-world experience clearly demonstrates that today's advanced satellite systems are unharmed by levels of interference much higher than allowed by the Commission's rules – which date back to the mid-1980s – and those proposed by the Commission in its *Notice*.[45]

Spacenet/StarBand simply propose to use <u>some</u>, but not nearly all, of this clearly demonstrated margin to continue the operational status quo in the domestic VSAT industry. The remainder would continue to provide a margin of safety between the allowed emissions and the capabilities of modern systems to withstand interference.

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[43] *See* Eutelsat Standard M, EESS 502 Issue 4, Rev. 0, at § 6.2 (Jan. 22, 1999) (39-25 log theta dBW/40kHz from 2.5° to 7°). Eutelsat recommends, but does not require, that earth station licensees limit off-axis EIRP to a value 4 dB lower (35-25 log theta dBW/40kHZ from 2.5° to 7°). *See ibid.* Even stations that meet the recommended level radiate interference levels 5.6 dB higher than the current FCC limit toward adjacent satellites.

[44] <u>See</u> Section 25.212, 47 C.F.R. § 25.212.

[45] Ironically, the proposed rules will require substantially lower power levels than those adopted in the mid-1980s. One would normally expect that improved technology would permit more flexibility, and thus higher power, than the earlier, less sophisticated satellite systems. The international experience indicates that that is the case; the Commission has not advanced any evidence to support its proposal to go in the opposite direction.

c. There Is No Basis For Imposing More Restrictive Rules

This experience of the satellite industry worldwide shows that there is no need to impose power limits more stringent than the FCC's current limits. As we demonstrated above, the major international satellite organizations allow the radiation of 9.6 dB more interference toward adjacent satellites than the current FCC rules, and as much as 15.9 dB more than some small antennas would be allowed under the proposed rules. Even the tighter non-mandatory "recommended" Eutelsat standard allows earth stations to radiate 5.6 dB more signal toward adjacent satellites than the current FCC standard, and as much as 10.9 dB more than some small antennas would be allowed under the proposed rules.

Further, domestic satellites are exposed to interference from earth stations transmitting analog carriers that is 6 dB higher than the interference from earth stations transmitting digital carriers. Finally, there are many non-compliant antennas in domestic service today that have caused no problems whatever due to their patterns.

This uncontroverted evidence demonstrates that the current interference rules are too strict, by as much as 10 dB. There is no reason to increase this huge safety margin further. To the contrary, sound policy dictates that the Commission invest some of it in the future of an industry that is uniquely able to deliver broadband advanced services to remote, tribal, and other underserved areas, while still retaining a more than adequate margin of safety.

3. Proposed Section 25.220 Will Materially Impair Existing and New VSAT Services

The Commission's proposal to require VSAT systems using sub-meter antennas to reduce power or coordinate with satellites within 6° of the target satellite is not only unnecessary to avoid harm to other satellite systems, but also threatens to impair existing service and to thwart the deployment of attractive new services by VSAT operators.

a. Reducing Power Will Adversely Affect Service

Because GSO FSS Ku-Band links are affected by rain attenuation, they typically need 2 dB or greater overall link margin to deliver acceptable service to customers. The link margin is directly related to the earth station transmit carrier EIRP and the carrier transmission configuration. Reducing the power spectral density allowed for sub-meter antennas at angles closer than two degrees, as proposed by the Commission, will limit information rates and degrade link margins. It will also produce inefficient spectrum utilization by requiring less-bandwidth-efficient transmission configurations. These limitations could severely limit the commercial feasibility of the GSO FSS Ku Band for broadband residential service.

As Spacenet/StarBand demonstrated above,[46] a representative 0.85 meter antenna would be required to reduce power nearly 5 dB to be approved under the reduced-power option. This reduction alone would render Ku-Band VSAT service using 0.85 meter antennas commercially nonviable, as link budgets simply do not have sufficient margin to deliver competitive broadband service at this power density level.

The Commission itself recognized that reducing "the earth station transmit power and power density to the extent necessary to compensate, decibel for decibel, for any shortfall in the antenna performance relative to the antenna standards of Section 25.209," would restrict "the capacity of extremely small antennas" and make them suitable "only

[46] *See* n.42, *supra*.

for narrowband, relatively low data rate, digital services, and possibly systems employing spread spectrum techniques ...."[47] Nonetheless, the *Notice* concludes that "[t]hese small antennas and low power levels, however, might be very practical for satellite-delivered Internet services."[48]

The Commission did not include any analysis in the *Notice* to support this conclusion. Our analysis, set forth in Exhibit A, indicates that the Commission's conclusion is erroneous. Reducing the transmit power and power density of the sub-meter antennas used by StarBand and other providers of satellite-based Internet service to the level required by proposed Section 25.220 would degrade the quality of service offered, thereby affecting the competitive position of VSAT operators. Using the representative 0.85 meter antenna discussed in Appendix A of the *Notice* at a power reduction of 5 dB, as required under the proposed power-reduction option, would reduce the inbound data rate by a factor of more than 3, to 47.4 kbps, as demonstrated in the attached Exhibit A.[49] At that level, the VSAT industry would be unable, using industry-standard methods, to provide inbound data rates that are as fast as those of 56 kbps telephone modems – much less the data rates possible using cable modems or DSL.[50]

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[47] *Notice* at ¶ 18.

[48] *Id.*

[49] If this earth station were required to lower its power a further 3 dB to comply with proposed Section 25.134(a)(1)(iii), the data rate would be reduced by a factor of almost 8, to 18.9 kbps.

[50] While StarBand might be able to increase the data rate by operating with a broader bandwidth, the cost of acquiring the additional satellite capacity would be prohibitive. According to the London Satellite Exchange On-Line Marketplace, a domestic U.S. FSS Ku-Band space segment capacity costs $5,370 /MHz/month – or $193,320/month for a typical 36 MHz transponder (approximately $2.32 million/year). Since space segment is a major cost element of a broadband satellite system, tripling the space-segment cost to compensate for the reduction in the inbound data rate would have a dramatic negative impact on the entire VSAT industry.

For those consumers living in geographic areas that make satellite delivery their only option for receiving advanced services, a mandatory reduction in transmit power and power density would effectively curtail their access to high-speed data service options. Relegating a sizeable portion of the nation's population to "second class status" when it comes to advanced services solely on the basis of where they happen to live and work is contrary to the stated Congressional intent behind enactment of Section 706 of the Communications Act. Consciously imposing such limitations on service choices for this sector of the population with no countervailing proven benefit cannot further the public interest. [51]

b. Coordination Requirements Are Impracticable

The alternative proposal in proposed Section 25.220 suffers from comparable defects. Under that proposal, applicants seeking authority to use non-compliant sub-meter antennas would be required to obtain affidavits:

(a) from the satellite operator acknowledging that the proposed earth station might receive unacceptable interference from adjacent satellites,
(b) from the satellite operator that it has coordinated the non-compliant earth station with all satellite networks within $\pm 6°$ of the satellite with which the station will communicate
(c) from the satellite operator that it will include the non-compliant earth station in any future coordination, and
(d) from the applicant that it will comply with any future coordination agreement reached by the satellite operator.[52]

[51] While VSAT operators might be able to market 1.2 meter antennas in rural and underserved areas, marketing its services with those antennas in suburban areas is problematic, as discussed in Section II.b.2.c *infra.* Without the customer-base offered by suburban households, the economic viability of the service becomes much more conjectural.

[52] *See Notice* at Appendix B, proposed Section 25.220(d).

In addition, any license granted to the applicant would be conditioned on the licensee agreeing to reduce power if "no good faith agreement can be reached between the satellite operator and the operator of a future 2° complaint satellite."[53]

This rule would not streamline the application procedure for the fastest-growing segment of the VSAT industry – satellite-based broadband service. Applicants, or their satellite vendor, would be required to coordinate with the operators of at least six satellites, any one of whom could delay the introduction of new services by merely dragging its feet in connection with the coordination process. Indeed, satellite operators could use the coordination process to extract benefits from the operator of the VSAT operator's target satellite or to give one of the VSAT operators using its satellite the opportunity to launch its service at the same time as the VSAT operator seeking coordination – thereby taking away the initial VSAT operator's "first-to-market" advantage.

Moreover, the need to coordinate with satellites within 6° of the earth station's principle satellite(s) also imposes an unnecessary burden on satellite operators, given the fact that the small antennas used to provide this service will not cause any greater interference to other satellites than a compliant antenna when the small antennas fall within the 29-25 log theta envelope at angles of 2° and greater from the main beam axis. As noted above, the small antennas that the Commission is likely to authorize under the Spacenet/StarBand proposal or under the proposals in the *Notice* will generally have main lobes that extend no farther than ±2° from the main lobe axis in the orbital plane, and will fall within the 29-25 log theta envelope specified in Section 25.209(a) at angles of 2° and

[53] *Id.*

greater from the main lobe axis. Therefore, from the standpoint of satellites at ±2°, ±4°, and ±6° from the target satellite, there is no difference between a non-compliant antenna and compliant antennas – or between a network of non-compliant antennas and a network of compliant antennas. Since the Commission routinely authorizes antennas that fall within the 29-25 log theta envelope without any coordination, there is no basis for requiring coordination with satellites at ±4° and ±6° for antennas that are within the 29-25 log theta envelope at angles of 2° and greater from the main lobe axis.[54]

Further, the requirement that the earth station licensee reduce power in the future if the satellite operator cannot successfully coordinate with future 2°-compliant satellites places a sword of Damocles over the earth station licensee. Any new satellite operator has the potential to impose significant new burdens on the operator relying on non-compliant antennas by refusing to coordinate or imposing unacceptable conditions on any agreement which accepted the operation of the non-compliant earth station.[55] As a result, VSAT licensees that planned to deploy large numbers of sub-meter antennas may be reluctant to invest in network infrastructure or to introduce innovative new services that rely on the low cost and ease of location of small antennas.

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[54] Spacenet/StarBand argue in the text that Section 25.209(g) should be amended to require that antennas fall within the 29-25 log theta envelope within 2° of the main beam axis. If this proposal is adopted, the coordination requirement would make some sense, as it would then apply only to antennas that do not fall within the 29-25 log theta envelope within 2° of the main beam axis.

[55] Spacenet/StarBand are aware that under Section 25.134(c) of the current rules, earth stations operating with non-compliant power levels may be required to reduce power if future coordinations will not accommodate the non-compliant operations. However, unlike earth stations using antennas that fall within the 29-25 log theta envelope at 2° and beyond, stations operating with non-compliant power actually do radiate more energy toward adjacent satellites than a compliant station. Therefore, the extension of this requirement to antennas that fall within the 29-25 log theta envelope at 2° and beyond is unwarranted.

While Spacenet/StarBand recognize that the Section 25.134(c) contains a provision similar to that proposed in Section 25.220, that provision, as well as the proposed coordination requirement here, is plainly at odds with the Commission's overall approach to spectrum management and that of the ITU. Indeed, we have not found any other Commission service in which new entrants can displace existing primary service. Thus, in the broadcast services, proposals to add new stations or channels or to modify existing facilities must protect other existing stations.[56] Similarly, certain land mobile, microwave, paging, and multipoint distribution/ITFS operations have historically been authorized on spectrum shared by multiple licenses in a given geographic area.

Yet, the coordination requirements in Parts 90 and 101 of the Commission's rules recognize that a primary objective of coordination is co-existence among current and future spectrum users without exposing pre-existing licensees to the threat of forced license modification. License modification to accommodate new applicants can be accomplished only through consensual arrangements, according to the Part 90 and Part 101 coordination procedures.[57] Indeed, the Commission, in *Connecting the Globe: A Regulator's Guide to Building a Global Information Community,* reiterates the fundamental ITU principal that that primary users within an allocated frequency band have equal rights to use of the spectrum, with the proviso that "[a] station ... has the right to be protected from any others that start operation at a later date."[58]

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[56] *See, e.g.* 47 C.F.R §§ 73.37 and 73.509

[57] *See* 47 C.F.R §§ 90.175 and 101.103

[58] Federal Communications Commission,*Connecting the Globe: A Regulator's Guide to Building a Global Information Community,* at Chapter VII. "Spectrum Allocation, Assignment and Enforcement" (1999).

Thus, the provisions of Section 25.134(c) are clearly an anomaly and appear to be based on a concern that experience indicates was unfounded. When the Commission introduced this coordination scheme into earth station licensing in 1991, it indicated that the scheme was intended to ensure that the authorization of sub-meter antennas did not foreclose future uses of the satellite band.[59] Even at that time, however, the Commission offered scant support for imposing this risk on VSAT operators, and no effort was made to distinguish how coordination was, and continues to be, implemented in other spectrum-based services operating on shared spectrum. This *Notice* presents a timely opportunity to reevaluate coordination requirements for earth stations, and to bring them into line with accepted ITU practices.

c. Use of Larger Antennas Is Not Commercially Feasible

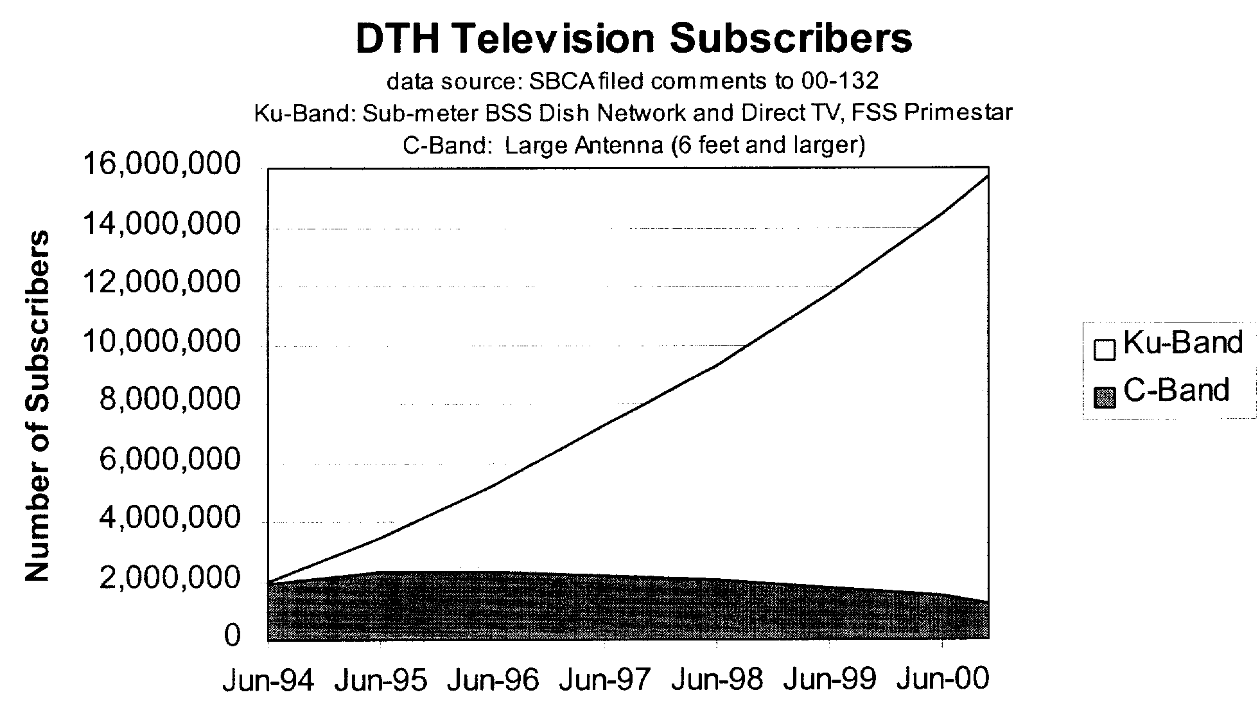
Spacenet/StarBand recognize that these concerns would be minimized, if not eliminated, if we used 1.2 meter or larger antennas. While that may be feasible in the commercial VSAT market and perhaps for truly rural, remote areas, small antennas are essential for bringing competitive broadband services to suburban homes and urban environments.[60] The sub-meter antennas are less costly; it is easier to find suitable locations for them; they are more acceptable to zoning boards, neighbors and others affected by them; they can be shielded from view more easily and inexpensively; they are more attractive for the residential user; and they require less structural support and

[59] In the Matter of Routine Licensing of Large Networks of Small Antenna Earth Stations Operating in the 12/14 GHz Frequency Bands, *Report and Order*, FCC Rcd. 7372, ¶¶ 13–18 (1991).

[60] Even in the commercial marketplace, smaller antennas are desirable and facilitate the marketing of VSAT services. They are easier to place and more aesthetically acceptable.

bracing and thus can be mounted on roofs, chimneys, walls and other locations where it may not be possible to mount larger antennas – even 1.2 meter antennas.

This fact is not only intuitive but is very clearly illustrated by the pattern of DTH video subscribership when Ku Band service was introduced. Although C-band DTH service had been available for a long time, and continued to grow modestly following the introduction of Ku-Band service, the smaller antennas eclipsed the larger ones in approximately 18 months:



While there are clearly differences between the acceptability of C band earth stations and a 1.2 meter antenna, the exponential growth of Ku-Band DTH services as compared to C-Band service is manifestly related to the size of the antenna. There is no reason to believe that sub-meter antennas are not more acceptable than 1.2 meter antennas, particularly in multiple dwelling unit environments and neighborhoods with restrictions on land uses. Thus, requiring VSAT operators to use these larger antennas will likely reduce penetration and negatively affect their business plans. Since there is no evidence that the use of these sub-meter antennas cause harm to adjacent satellites, there is no reason for the Commission to thwart the use of these smaller antennas and hinder the deployment of the newer satellite-based services the VSAT is and will be offering.

C. The Commission Should Relax Its Current Rules to Give VSAT Operators More Flexibility

1. The Commission Should Increase Section 24.134(a) Baseline Power <u>Density Limit If It Adopts Its Proposed Revisions to the Rules</u>

In its *Notice,* the Commission seeks comment on whether it should increase the permissible "baseline" power density limits to reflect technological advances and smaller antenna requirements.[61] Commenters urging any increase in these power levels are requested to demonstrate that (a) the increased power levels will not result in increased interference to other satellite systems and (b) their proposals are consistent with the RF hazard requirements of Part 1, Subpart I of the Commission rules.

If the Commission accepts our proposals to (a) modify Section 25.209(g) to measure antenna performance standards at 2° in the orbital plane and 3° perpendicular to the orbital plane,[62] and (b) allow operators more flexibility to use random access schemes, which is discussed below,[63] Spacenet/StarBand do not believe that it is necessary to increase the current antenna input flange density limit from -14 dBW/4kHz

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[61] *See Notice* at ¶ 40.

[62] *See* Section II.B *supra.*

[63] *See* Section II.D *infra.*

for digital carriers. With our proposals, the current power density levels are sufficient to assure quality service.

However, if the Commission adopts its proposed Section 25.220, then Spacenet/StarBand urge the Commission to raise the current -14 dBW/4kHz limit by 3 dB to -11 dBW/4kHz. This increase in the baseline power density level is consistent with the operating parameters used by the international satellite community, existing experience with sub-meter antennas, and the higher levels permitted for analog signals, as explained in detail in Section II.B, *supra*. As discussed above, modern satellite systems have clearly demonstrated their capability to withstand interference nearly 10 dB higher than allowed by the FCC's current rules without undue harm.

Further, this proposed change would not necessarily increase the risks of excessive RF radiation since it would not automatically result in a corresponding increase in earth station power generally. The limits in Sections 25.134 and 25.212 are power spectral density limits (power per bandwidth), and, as a result, higher values can be achieved with the same transmitter power by reducing the transmitted bandwidth. Therefore, there would be no direct effect on radiation levels. That issue should be treated on a case-by-case basis in connection with the processing of earth station applications as it is now.

Thus, if the Commission adopts its proposed Section 25.220, Spacenet/StarBand urge the Commission to increase the permissible power density levels, thereby investing in the future of broadband competition some of the margin between the standards set forth in that section and the standards used internationally rather than miserly hoarding it as an unnecessary safety margin.

2. The Commission Should Increase Allowable Downlink Power

Spacenet/StarBand also believe that the Commission can and should increase the allowable downlink power in order to offset some of the damage to the link budget which will result if the Commission adopts its proposal to reduce VSAT remote station power spectral density. By increasing the allowable downlink power, the Commission will also allow VSAT systems to overcome additional interference which will be caused by NGSO terrestrial sharing of the Ku Band, and to take advantage of technological improvements in the satellite industry.

As noted earlier, the Commission's proposal to reduce the power spectral density of earth stations is of substantial concern to the VSAT industry, and especially worrisome with respect to the promise of residential satellite Internet service. Some of the potential degradation in the deliverable service occasioned by the proposed power reduction could be mitigated by allowing an increase in the downlink power spectral density. Spacenet/StarBand emphasize that this could only partially compensate for the reduction in VSAT power density because of the other sources of noise that contribute to link degradation.

However, increasing the downlink power density will also aid VSAT systems in dealing with the increased interference that will result from the Commission's recent decision to allow NGSO systems to share the Ku band.[64] The increased interference from NGSO operations resulting from that decision will have a serious impact on GSO FSS

[64] *See* In the Matter of Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range, *First Report and Order and Further Notice of Proposed Rule Making*, ET Dkt No. 98-206 (released Dec. 8, 2000) (*"NGSO Order").*

link margins that can be partially offset by an increase in downlink EIRP, which is necessary to mitigate the effects of this interference to the degree that it can.

In order to address this degradation of service, Spacenet/StarBand urge the Commission to amend Sections 25.134 and 25.212 (i) to increase the downlink EIRP density for wideband digital carriers from +6.0 to +16.0 dBW/4kHz and (ii) to increase the downlink EIRP density for narrowband digital carriers form +6.0 to +9.0 dBW/4kHz. The Commission should maintain the uplink flange density specification for digital carriers at -14.0 dBW/4kHz[65] and maintain the analog uplink and downlink density specifications at +13.0 and -8.0 dBW/4kHz respectively.[66] The technical basis supporting the higher downlink EIRP density limits proposed by Spacenet/StarBand is set forth in Exhibit B to these Comments. As demonstrated in Exhibit C to these Comments, which presents the ITU downlink power density recommendations, these proposals are consistent with the international standards for digital services. That Exhibit also shows that the ITU and Spacenet/StarBand power density recommendations are in agreement with the current Commission regulations for international GSO FSS Ku-Band operations.

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[65] This recommendation is based on the assumption that the Commission (a) adopts our proposal to amend Section 25.209(g) to measure performance at 2° in the orbital plane and 3° in the perpendicular plane is adopted and (b) does not require narrowband digital carriers operated for VSAT inbound channels to reduce their power density levels on the basis of their use of proven random access techniques. If the Commission does not adopt those proposals, then Spacenet/StarBand believe that the Commission should increase the uplink flange density specification by 3 dB. *See* Section II.C.1 *supra*.

[66] Wideband digital carriers have a constant spectrum envelope that provides a uniform power spectral density across the transponder bandwidth. However, full transponder analog transmissions via satellite utilize FM modulation, which is not well behaved in terms of its power spectral density distribution across the transponder bandwidth. Therefore, the downlink interference realized by earth stations from a wideband digital carrier operating at a downlink EIRP spectral density of +16 dBW/4kHz with uniform distribution is less than that introduced by an analog carrier operating at +13 dBW/4kHz.

Our proposal will offset the outbound link degradation and improve the efficiency of spectrum utilization, but will have only a marginal effect on the inbound link degradation. For this reason, as we showed in Sections II.B and II.C.1 *supra,* the Commission must be extraordinarily careful in evaluating its proposals with respect to VSAT remote station transmit power densities. Inbound VSAT network links will suffer more than 3 dB of degradation from NGSO operations. Further reductions of approximately 5 dB for antennas that are non-compliant between 1.25° and 2°, or 3 dB for random access techniques, would prove harmful to the VSAT industry by preventing it from offering competitive broadband services. This will not only hurt broadband competition, it will also seriously affect the timely provision of affordable broadband service to the many Americans who live in rural, tribal, and other underserved areas.

Spacenet/StarBand also believe that the proposal to increase downlink EIRP densities for digital carriers will increase the efficiency of Ku-Band satellite service in general by taking advantage of improvements in satellite technology. In the 1980s and early 1990s, the highest power traveling wave tube amplifiers ("TWTAs") utilized by Ku-Band satellite transponders were on the order of 20 watts per transponder. Today all three U.S. operators, GE Americom, Loral Skynet and PanAmSat, have replaced the 1980s satellites and are operating Ku-Band transponders utilizing TWTAs with a maximum power output on the order of 110 watts or greater. Additionally, non-domestic operators, such as Telesat Canada and Satmex, are operating comparable high power Ku-Band satellites with coverage regions extending far into the U.S. The satellite industry's on-board high power amplifier improvements alone have provided a 7 dB increase in the available satellite transmit power for Ku-Band links.

In addition to amplifier performance improvements, advances in satellite design, construction, and launch capabilities have enabled more Ku-Band transponders per satellite than at the time that the power density limits were established. The increased number of transponders supported per satellite has allowed the bandwidth per transponder to decrease from a typical 72 or 54 MHz in the 1980s to 36 MHz today. Frequency re-use realized by dual polarization and multi-beam coverage has enabled current satellites to offer service on twenty-four or more 36 MHz Ku-Band transponders within the 500 MHz allocated to the domestic GSO FSS Ku-Band. While the satellite improvements have enabled narrower bandwidths per transponder, and thus enabled more transponders per satellite, the reduced bandwidth per transponder also has the effect of increasing the power density available per transponder. For example, a 36 MHz transponder will have a 3 dB higher maximum available satellite downlink EIRP spectral density than a 72 MHz transponder with the same TWTA power, because the power is distributed over half of the previously available bandwidth.

The Commission has declined to allow domestic GSO FSS Ku-Band operators to expand their operations beyond the current duplex 500 MHz bands to the extended Ku bands. Therefore, to expand utilization of the allocated resources, advanced satellite designs incorporate multiple beams to facilitate increased capacity by additional frequency re-use. Multiple-beam operation increases the spacecraft's antenna gain to focus the input energy in a more concentrated geographical area, while providing sufficient isolation from adjacent geographical areas to allow frequency re-use. As with narrow transponder bandwidths, the increased spacecraft antenna gain produces higher downlink EIRP spectral densities toward the earth's surface.

As shown in Exhibit B, our proposal will provide better link performance than the current rules and will make the Commission's rules consistent with the current state-of-the-art satellite technology.

D. The Proposed Rules Governing Random Access Techniques Will Preclude Competitive Broadband VSAT Services

1. The Commission's Rejection of the Industry's Position With Respect to Access Schemes Is Arbitrary and Capricious

In the Spacenet Petition, Spacenet urged the Commission to clarify Section 25.134 of its rules to allow VSAT access schemes, such as the slotted ALOHA scheme used by Spacenet, that entail collisions between remote stations on the inbound channels pursuant to a statistical equation tied to the probability of collisions, as long as each transmitting earth station individually satisfies the power density limits of Section 25.134(a) and the maximum duration of any single collision is less than 100 milliseconds.[67] As noted above, Hughes filed comments in that proceeding arguing that Spacenet's formula was too stringent and urging the Commission to allow any access scheme as long as the average power radiated toward the target satellite by all remote earth stations in the network did not exceed the levels in Section 25.134.[68]

No VSAT or satellite operator opposed either proposal, and no one submitted any evidence that Spacenet's proposal or the use of Aloha access schemes in general would result in unacceptable levels of interference.[69] Indeed, as noted above, PanAmSat urged

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[67] *See Spacenet Order* at ¶ 7.

[68] *See* n.37 *supra.*

[69] ALOHA Networks, Inc. filed comments arguing that Spacenet erred in its proposal by using a "Poisson" probability function rather than a binomial probability function. The Commission has concluded that Spacenet was correct in using the "Poisson" function. *See Notice* at ¶ 54, *Notice* at Appendix E.

the Commission to "update and refine" its VSAT rules to reflect the industry's long experience that "the power level limits in the rules now are more restrictive than they need to be, or should be."[70]

Notwithstanding this unanimous industry position, the Commission rejected Spacenet's proposal without any analysis or any explanation as to why it might result in unacceptable levels of interference or was otherwise unacceptable.[71] Instead, it proposed adopting, in the name of "a more general and simplified approach,"[72] the restrictive regulatory regime set forth in the *Notice*.

The Commission's rejection of, and indeed, refusal to seek comment on the industry suggestions is arbitrary and capricious.[73] As we have noted throughout these comments, the rules proposed in this *Notice* will, if adopted, require substantial modification of existing, well established practices in the VSAT industry. Those rules are also likely to impair the ability of the VSAT industry to use satellite technology to provide Internet and other broadband services to residential consumers. Those existing services and new services were developed and deployed in reliance on the existing rules

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[70] *See* n.36 *supra*.

[71] *See Notice* at ¶ 55. While the Commission did not explain why it rejected Spacenet's proposal, there is an implication in the *Notice* that it was concerned that the increasing use of sub-meter antennas for Internet access would increase the risks of interference. As shown below, that concern is unfounded. *See*, Section II.D.2, *infra*.

[72] *Id.* at ¶ 54.

[73] The Commission's rejected Hughes' proposal on the grounds that it "would not adequately address cases where the bandwidth used for an earth station causing interference is wider than the bandwidth used by an earth station impacted by the interference." *Ibid.* As explained in Section II.D.4, *infra*, that conclusion is incorrect.

as written and with a view to meeting marketplace requirements for reliability and quality of service.

In the absence of demonstrated harm or at least the clear probability that harm will result, the Commission should not jeopardize those plans or impair the public's ability to enjoy the services which Spacenet/StarBand and others plan to bring to the market. VSAT systems have been operating for twenty years, frequently under loosely defined regulatory regimes, and, with rare exceptions, the industry has addressed any operational problems by good engineering design or cooperation amongst the participants in the industry. The Commission has not explained, nor can it, why this de-regulatory, market-based approach will not continue to operate efficiently as new, residential and other VSAT services are introduced. As the Commission is aware, the industry is competitive and thus each participant is motivated to provide its customers with reliable, high quality service. To date, that motivation has succeeded in a manner that has not adversely affected anyone.

Moreover, reliance on the industry and the marketplace is the approach Congress clearly sought to foster when it enacted the 1996 Telecommunications Act and required the Commission to review its rules biennially to determine whether they continued to serve the public interest. Historically, the Commission has followed this approach and regulated the satellite industry lightly and only with consultation with the industry. That approach has worked well and the Commission should not abandon it now, especially in light of the regulatory philosophy of the 1996 Act.

The Commission should not, indeed cannot, ignore that Congressional direction by rejecting, without analysis or reason, proposals fully accepted by the industry where there is no evidence of harm. The Commission's proposals in this *Notice* will only harm a vibrant industry that promises to bring new and innovative services to the public, increase competition in the provision of broadband services, and promote Congress' desire to foster new technologies and to make broadband service widely available to all Americans.

2. An Increase In The Number of Earth Stations Will Not Increase the Risks of Interference

While Spacenet/StarBand recognize that, at first blush, it might seem that an increase in the number of VSAT stations would increase the probability of collisions, further consideration demonstrates that that is not the case. The probability of multiple simultaneous transmissions is approximated by the following Poisson function:

$$P[k] = G^k \div k! \times e^{(-G)}$$

where: G is the load or average transmissions per slot
k is the number of simultaneous transmissions and $k!$ is k factorial
$P[k]$ is the probability for k simultaneous transmissions.[74]

This formula clearly establishes that the probability is a function only of the network loading.[75] Networks are designed to accommodate the expected maximum traffic, and incorporate some form of congestion control to prevent exceeding the design loading.

[74] *See Spacenet Orde*; *Notice* at ¶ 54 and Appendix E, § II.A (accepting the Poisson model for Aloha collision probabilities).

[75] For very low numbers of transmitters, the Poisson function given above overestimates the probability of collision by a small amount. The approximation converges with actuality as the number of stations increases, and is within 0.1% for any practical loading when there are fifty or more transmitters.

If networks did not include congestion control, an increase in the number of users could increase the loading above the target value, and network response would be sluggish. In short, the service would be commercially unacceptable. Thus, an increased probability of collisions is not in the provider's interest. Optimum throughput with acceptable response is achieved with loading of approximately 36–38%. Beyond that value, the marginal gain in throughput is more than offset by the rapidly deteriorating network response. VSAT networks therefore incorporate dynamic loading control to prevent these difficulties – thereby reducing the probability of collisions. As such, the Commission's proposed regulatory intrusion is unnecessary; the industry's need to assure a service that is competitive with wireline and other terrestrial services will preclude excessive collisions.

3. There Is No Basis For the 3 dB Reduction In Power

As part of the satellite communications design process, link budgets are generated for each carrier to ensure that system performance is provided in accordance with customer requirements. In link budget calculations, degradations to the link are assigned for both thermal and interference related noise contributions. These are combined to obtain the expected overall link carrier-to-noise power spectral density ratio, or C/N_0, a performance metric for the link.

As shown in Exhibit D, domestic satellite systems are designed to operate properly while receiving both thermal noise and interfering signals from earth stations targeted at other satellites. As Exhibit D demonstrates, satellite systems receive twice the average noise level 5% of the time. As demonstrated in the *Spacenet Petition*, and accepted by the Commission in the *Spacenet Order*,[76] the probability of two earth stations transmitting simultaneously in an Aloha network at maximum practical loading is also approximately 5%. Consequently, there is no need to require a 3 dB power reduction in order to preclude harmful interference to adjacent satellites.

4. Mismatched Bandwidths Will Not Increase the Risk Of Interference

In both the *Spacenet Order* and its *Notice,* the Commission claims that "victim" satellite systems with narrower bandwidths than the interfering transmissions will be "significantly degraded, possibly beyond recovery."[77] Because the rules related to adjacent satellite interference on the earth-to-space link are defined on a power spectral density basis (power per unit bandwidth), interference caused by collisions from VSAT transmissions will not affect the victim systems with smaller relative bandwidths to any greater extent than a carrier of equal bandwidth. As explained in detailed in Exhibit D, this is due to the fact that the victim earth station's receiver will only receive the amount of the interference power that falls within the narrower bandwidth to which the victim receiver is tuned.

5. The Commission Should Adopt Hughes' Average Power Proposal

In the Spacenet Petition, Spacenet proposed to interpret (or, in the alternative, to amend) Section 25.134 explicitly to allow VSAT networks to operate with the existing uplink power density levels as long as (i) each station individually meets the power density requirement, (ii) the probability of collisions is below an envelope specified by a

[76] *See Spacenet Order* at Appendix A, Table 1.

[77] *Spacenet Order* at ¶ 10; *see also Notice* at ¶ 54.

Poisson function, and (iii) no individual collision lasts longer than 100 mS.[78] The Commission states that it rejected this proposal because "we believe that a more general and simplified approach will better facilitate the licensing of earth stations that use [random access] techniques."[79] The proposals embodied in proposed Sections 25.134(a)(1)(i) through (iv), however, hardly qualify as more general or simpler than the Spacenet proposal.[80]

While the Commission seems to suggest that Spacenet's proposal might not be sufficiently general, its own proposal is the least general possible — a simple list of the presently-available techniques. As new techniques are developed, the list would need constantly to be amended. The most general and simplest proposal is that of Hughes Network Systems. Hughes proposed to adopt a modification of the Spacenet proposal by changing clause (ii) to specify that the average power of the VSAT network must not exceed the average power of one station transmitting continuously. Spacenet has supported this proposal, and continues to support it.

The Commission rejected the average-power proposal "because it would not adequately address cases where the bandwidth used for an earth station causing interference is wider than the bandwidth used by an earth station impacted by the interference."[81] As we demonstrated above, there is no foundation for this proposition

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[78] *See Spacenet Order* at ¶ 7.

[79] *Notice* at ¶ 54.

[80] In addition, Spacenet/StarBand note that the Commission's assumption that Reservation TDMA access schemes will not result in collisions is misplaced. Although the reserved TDMA channels generally operate without collisions, Reservation TDMA networks typically use an Aloha channel to allocate the reserved channels.

[81] *Notice* at ¶ 54 (citing *Spacenet Order* at ¶ 10).